

**Claims**

- 5 1. A pharmaceutical composition for controlled release of at least one opioid into an aqueous medium by erosion of at least one surface of the composition, the composition comprising
- 10           iii) a matrix composition comprising a) a polymer or a mixture of polymers, b) an active substance and, optionally, c) one or more pharmaceutically acceptable excipients, and
- iv) a coating having at least one opening exposing at the one surface of said matrix, the coating comprising
- 15               a) a first cellulose derivative which has thermoplastic properties and which is substantially insoluble in the aqueous medium in which the composition is to be used,
- and at least one of
- 20               b) a second cellulose derivative which is soluble or dispersible in water,
- c) a plasticizer, and
- d) a filler,
- wherein the matrix composition has a conus-like shape so that the surface area exposed to the aqueous medium increases at least during initial erosion of the matrix composition, and
- 25           the dissolution of the opioid - when tested in a Dissolution Test as described herein with or without application of sinkers - results in a zero order release of at least 80% of the opioid contained in the composition.
- 30 2. A pharmaceutical composition according to claim 1, wherein the surface area exposed is increasing during the first 0.5 hours such as, e.g., during the first 1 hour, during the first 1.5 hours, during the first 2 hours, during the first 3 hours, during the first 5 hours or during the first 6 hours.
- 35 3. A pharmaceutical composition according to claim 1 or 2, wherein the increase in surface area relates to an increase in diameter of the surface area of at least one exposed surface area upon erosion of that surface, and the ratio between the largest

and smallest diameter is decreasing from about 2.5 to 1 during the erosion, such as from about 2 to 1, such as from about 1.8 to 1, such as from about 1.6 to 1, such as from about 1.5 to 1, such as from about 1.4 to 1 such as from about 1.3 to 1, such as from about 1.2 to 1.

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4. A pharmaceutical composition according to any of the preceding claims, wherein the mean plasma concentration 8 hours after oral administration to at least 6 healthy adult humans is at least 40% of the mean maximal concentration obtained by the dose, such as, e.g., at least 50% or at least 60% of the mean maximal concentration,

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5. A pharmaceutical composition according to any of the preceding claims, wherein the mean plasma concentration 10 hours after oral administration to at least 6 healthy adult humans is at least 35% of the mean maximal concentration obtained by the dose, such as, e.g., at least 40% or at least 50% of the mean maximal concentration.

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6. A pharmaceutical composition according to any of the preceding claims, wherein the mean plasma concentration 12 hours after oral administration to at least 6 healthy adult humans is at least 25% of the mean maximal concentration obtained by the dose, such as, e.g., at least 30%, at least 35% at least 40% or at least about 45% of the mean maximal concentration.

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7. A pharmaceutical composition according to any of the preceding claims for administration once or twice daily.

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8. A pharmaceutical composition according to any of the preceding claims for administration once daily.

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9. A pharmaceutical composition according to any of the preceding claims, wherein the mean plasma concentration after oral administration of a single dose to at least 6 healthy adult humans is at least 33% of the mean maximal concentration for at least 15 hours such as, e.g., for at least 17 hours, for at least 19 hours or for at least 20 hours.

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10. A pharmaceutical composition according to any of the preceding claims, wherein the mean plasma concentration after oral administration of a single dose to at least 6 healthy adult humans is at least 50% of the mean maximal concentration for at least 6

hours such as, e.g., for at least 8 hours, for at least 9 hours, for at least 10 hours or for at least 11 hours.

5 11. A pharmaceutical composition according to any of the preceding claims, wherein the mean plasma concentration after oral administration of a single dose to at least 6 healthy adult humans is at least 75% of the mean maximal concentration for at least 3 hours such as, e.g., for at least 3.3 hours, for at least 3.5 hours, for at least 3.7 hours or for at least 3.9 hours.

10 12. A pharmaceutical composition according to claim 8, wherein the mean plasma concentration 12 hours after oral administration of a single dose is at least 20% such as, e.g., at least 25% or at least 30% of the mean maximal concentration, and/or the mean plasma concentration 18 hours after oral administration is at least 20% such as, e.g., at least 25%, at least 30% or at least 35% of the mean maximal concentration,  
15 and/or the mean plasma concentration 24 hours after oral administration is at least 20% such as, e.g., at least 25% or at least about 30% of the mean maximal concentration.

20 13. A composition according to any of the preceding claims, wherein the opioid is selected from the group consisting of alfentanil, allylprodine, alphaprodine, aniloridine, benzylmorphine, bezitramide, buprenorphine, butophanol, clonitazene, codeine, cyclazocine, desomorphine, dextromoramide, dezocine, diapromide, dihydrocodeine, dihydromorphine, dimenoxadol, dimephetanol, dimethylthiambutene, dioxaphetyl  
25 butyrate, dipipanone, eptazocine, ethoheptazine, ethylmethylthiambutene, ethylmorphine, etonitazene, fentanyl, heroin, hydrocodone, hydromorphone, hydroxypethidine, isomethadone, dextropropoxyphene, ketobemidone, levallorphan, levorphanol, levophenacymorphan, lofentanil, meperidine, meptazinol, metazocine, methadone, metopon, morphine, morphine 6- glucuronide, morphine 3-glucuronide, myrophine, nalbuphine, narccine, nicomorphine, norlevorphanol, normethadone,  
30 nalorphine, normorphine, norpipanone, opium, oxycodone, oxymorphone, papaveretum, pentazocine, phenadoxone, phenomorphan, phenazocine, phenoperidine, piminodine, piritramide, propheptazine, promedol, properidine, propiram, propoxyphene, sufentanil, tilidine, tramadol, and pharmaceutically acceptable salts, complexes, solvates or anhydrides thereof, and mixtures thereof.

35 14. A composition according to any of the preceding claims, wherein the opioid is morphine, morphine 6- glucuronide, morphine 3-glucuronide or mixtures thereof.

15. A composition according to any of the preceding claims, wherein the active substance is a pharmaceutically active powder.
- 5      16. A composition according to claim 15, wherein the powder has a particle size of from about 0.1  $\mu\text{m}$  to about 500  $\mu\text{m}$ , typically from about 0.5  $\mu\text{m}$  to about 300  $\mu\text{m}$ , more typically from about 1  $\mu\text{m}$  to about 200  $\mu\text{m}$ , especially from about 5  $\mu\text{m}$  to about 100  $\mu\text{m}$ .
- 10      17. A composition according to any of the preceding claims, wherein the opioid is present in the matrix composition in a concentration of from about 0.1 to about 98% w/w such as, e.g. at the most about 90% w/w, at the most about 85% w/w, at the most about 80% w/w, at the most about 75% w/w, at the most about 70% w/w, at the most about 65% w/w or at the most about 60% w/w.
- 15      18. A composition according to any of the preceding claims, wherein about 50% w/w of the opioid is released from the composition within 3-5 hours as measured by the dissolution test described herein.
- 20      19. A composition according to any of the preceding claims, wherein about 75% w/w of the opioid is released from the composition within 4-10 hours as measured by the dissolution test described herein.
- 25      20. A composition according to any of the preceding claims, wherein the composition – when tested in an *in vitro* dissolution system according to USP (paddle, 50 rpm, buffer pH 6.8 without sinkers) – releases at least about 80% w/w of the total amount of the opioid in a time period of from about 5 to about 10 hours such as, e.g., from about 6 to about 9 hours such as e.g from about 7 to 8 hours or about 7.5 hours after start of the test.
- 30      21. A composition according to any of the preceding claims, wherein the composition – when tested in an *in vitro* dissolution system according to USP (paddle, 50 rpm, buffer pH 6.8 with sinkers) – releases at least about 80% w/w of the total amount of the opioid in a time period of from about 4 to about 9 hours such as, e.g., from about 5 to about 8 hours such as e.g from about 6 to 7 hours or about 6 hours after start of the test.
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22. A composition according to any of the preceding claims, wherein the composition – when tested in an *in vitro* dissolution system according to USP (paddle, 50 rpm, buffer pH 6.8) – releases the opioid so that when 30% of the time to release at least about 80% w/w of the total amount of the opioid is reached - then from about 10% to about 50% such as, e.g., from about 15% to about 40% w/w, from about 20% to about 30% or about 23-27% w/w is released.
23. A composition according to any of the preceding claims, wherein the composition – when tested in an *in vitro* dissolution system according to USP (paddle, 50 rpm, buffer pH 6.8) – releases the opioid so that when 50% of the time to release at least about 80% w/w of the total amount of the opioid is reached - then from about 20% to about 60% w/w such as, e.g., from about 30% to about 50% w/w or about 42-47% w/w is released.
24. A composition according to any of the preceding claims, wherein the composition – when tested in an *in vitro* dissolution system according to USP (paddle, 50 rpm, buffer pH 6.8) – releases the opioid so that when 60% of the time to release at least about 80% w/w of the total amount of the opioid is reached - then from about 30% to about 80% w/w such as, e.g., from about 40% to about 70% w/w, from about 50 to about 60% or about 52-58% w/w is released.
25. A composition according to any of the preceding claims, wherein the composition – when tested in an *in vitro* dissolution system according to USP (paddle, 50 rpm, buffer pH 6.8) – releases the opioid in the following manner:
- within the first 2 hours after start of the test from about 0 to about 30% w/w of the opioid is released,
- within the first 5 hours after start of the test from about 25% to about 80% w/w of the opioid is released,
- within the first 7 hours after start of the test from about 40% to about 100% w/w of the opioid is released.
26. A composition according to any of the preceding claims, wherein the composition has a dissolution pattern that resembles that of Figure 21 herein, the composition being tested under similar conditions.

27. A composition according to any of the preceding claims wherein the matrix composition has a shape selected from the shapes defined in Table A herein.
- 5 28. A composition according to claim 24, wherein the shape corresponds to cone 1 or 5 in Table A herein.
29. A composition according to any of the preceding claims, wherein the polymer is a substantially water soluble or crystalline polymer or a mixture of substantially water  
10 soluble and/or crystalline polymers.
30. A composition according to any of the preceding claims, wherein the polymer matrix comprises a polyglycol.
- 15 31. A composition according to any of the preceding claims, wherein the matrix comprises a homopolymer and/or a copolymer.
32. A composition according to any of the preceding claims, wherein the matrix comprises a polyethylene glycol, a polyethylene oxide and/or a block copolymer of  
20 ethylene oxide and propylene oxide including including poly(ethylene-glycol-b-(DL-lactic acid-co-glycolic acid) - b- ethylene glycol (PEG-PLGA PEG), poly((DL-lactic acid-co-glycolic acid) - g-ethylene glycol) (PLGA-g-PEG), and polyethylene oxide - polypropylene oxide (PEO-PPO).
- 25 33. A composition according to claim 32, wherein the polyethylene glycol, a polyethylene oxide and/or a block copolymer of ethylene oxide and propylene oxide has a molecular weight of from about 20,000 daltons, such as, e.g., from about 20,000 to about 700,000 daltons, from about 20,000 to about 600,000 daltons, from about  
30 35,000 to about 500,000 daltons, from about 35,000 to about 400,000 daltons, from about 35,000 to about 300,000 daltons, from about 50,000 to about 300,000 daltons, such as, e.g. about 35,000 daltons, about 50,000 daltons, about 75,000 daltons, about 100,000 daltons, about 150,000 daltons, about 200,000 daltons, about 250,000 daltons, about 300,000 daltons or about 400,000 daltons.
- 35 34. A composition according to claim 32, wherein the block copolymer of ethylene oxide and propylene oxide comprises up to about 30% w/w of the propylene oxide

based block, and has a molecular weight of about 5,000 daltons, typically about 5,000 to about 30,000 daltons such as, e.g. from about 8,000 to about 15,000 daltons.

5 35. A composition according to any of the preceding claims, wherein the matrix comprises a polymer which has a melting point of about 20-120°C such as, e.g. from about 30 to about 100°C or from about 40 to about 80°C.

10 36. A composition according to any of the preceding claims, wherein the polymer is a polyethylene oxide having a molecular weight of at least 100,000 daltons and at the most 300,000 daltons.

37. A composition according to any of the preceding claims, wherein the matrix composition comprises PEO 200,000 NF and/or PEO 200,000 LF.

15 38. A composition according to any of the preceding claims, wherein the matrix comprises a pharmaceutically acceptable excipient.

20 39. A composition according to any of the preceding claims, wherein the pharmaceutically acceptable excipient is selected from the group consisting of inorganic acids, inorganic bases, inorganic salts, organic acids or bases and pharmaceutically acceptable salts thereof, saccharides, oligosaccharides, polysaccharides, and cellulose and cellulose derivatives.

25 40. A composition according to claim 39, wherein the organic acid is a mono-, di-, oligo, polycarboxylic acid or amino acids such as, e.g. acetic acid, ethanoic acid, succinic acid, citric acid, tartaric acid, acrylic acid, benzoic acid, malic acid, maleic acid, adipic acid, angelic acid, ascorbic acid/vitamin C, carbamic acid, cinnamic acid, citramalic acid, formic acid, fumaric acid, gallic acid, gentisic acid, glutaconic acid, glutaric acid, glyceric acid, glycolic acid, glyoxylic acid, lactic acid, levulinic acid, 30 malonic acid, mandelic acid, oxalic acid, oxamic acid, pimelic acid, pyruvic acid, aspartic and glutamic acid.

35 41. A composition according to claim 39, wherein the inorganic acid is pyrophosphoric, glycerophosphoric, phosphoric such as ortho or meta phosphoric, boric acid, hydrochloric acid, or sulfuric acid.

42. A composition according to claim 39, wherein the suitable inorganic compounds include aluminium.
43. A composition according to claim 39, wherein the suitable organic bases are selected from the group consisting of *p*-nitrophenol, succinimide, benzenesulfonamide, 2-hydroxy-2cyclohexenone, imidazole, pyrrole, diethanolamine, ethyleneamine, tris (hydroxymethyl) aminomethane, hydroxylamine and derivatives of amines, sodium citrate, aniline, and hydrazine.
44. A composition according to claim 39, wherein the suitable inorganic bases are selected from the group consisting of aluminium oxide such as, e.g., aluminium oxide trihydrate, alumina, sodium hydroxide, potassium hydroxide, calcium carbonate, ammonium carbonate, ammonium hydroxide, KOH and the like.
45. A composition according to claim 39, wherein the pharmaceutically acceptable salt of an organic acid is e.g. an alkali metal salt or an alkaline earth metal salt such as, e.g. sodium phosphate, sodium dihydrogenphosphate, disodium hydrogenphosphate etc., potassium phosphate, potassium dihydrogenphosphate, potassium hydrogenphosphate etc., calcium phosphate, dicalcium phosphate etc., sodium sulfate, potassium sulfate, calcium sulfate, sodium carbonate, sodium hydrogencarbonate, potassium carbonate, potassium hydrogencarbonate, calcium carbonate, magnesium carbonate etc., sodium acetate, potassium acetate, calcium acetate, sodium succinate, potassium succinate, calcium succinate, sodium citrate, potassium citrate, calcium citrate, sodium tartrate, potassium tartrate, calcium tartrate, zinc gluconate, zinc sulphate etc.
46. A composition according to claim 39, wherein the inorganic salt is sodium chloride, potassium chloride, calcium chloride, magnesium chloride etc.
47. A composition according to claim 39, wherein the pharmaceutically acceptable excipient is selected from glucose and other monosaccharides, ribose, arabinose, xylose, lyxose, allose, altrose, inositol, glucose, sorbitol, mannose, gulose, idose, galactose, talose, mannitol, fructose, lactose, sucrose, and other disaccharides, dextrin, dextran or other polysaccharides, amylose, xylan, cellulose and cellulose derivatives such as, e.g. microcrystalline cellulose, methyl cellulose, ethyl cellulose, ethylhydroxyethyl cellulose, ethylmethylcellulose, hydroxyethylcellulose, hydroxyethylmethyl cellulose, carboxymethyl cellulose, hydroxypropyl cellulose,



hydroxymethylpropyl cellulose, hydroxypropylmethyl cellulose, amylopectin, pectin, starch, sodium starch etc., kaolin, bentonit, acacia, alginic acid, sodium alginate, calcium alginate, gelatin, dextrose, molasses, extract of Irish moss, panwar gum, ghatti gum, mucilage of isapol husk, veegum, glycollate, magnesium stearate, calcium  
5 stearate, stearic acid, talc, titanium dioxide, silicium dioxide, clays, croscarmellose, gums, agar etc.

48. A composition according to any of the preceding claims further comprising a pharmaceutically acceptable excipient selected from the group consisting of fillers,  
10 diluents, disintegrants, glidants, pH-adjusting agents, viscosity adjusting agents, solubility increasing or decreasing agents, osmotically active agents and solvents.

49. A composition according to any of the preceding claims, wherein the at least one opioid has a solubility of at the most about 3 mg/ml such as, e.g. at the most about 1  
15 mg/ml, at the most about 0.1 mg/ml, at the most about 0.05 mg/ml such as, e.g. at the most about 0.001 mg/ml in water at ambient temperature.

50. A composition according to claim 46, wherein the matrix composition comprises a pharmaceutically acceptable excipient which has a solubility of at least 1 mg/ml such  
20 as, e.g. at least about 3 mg/ml, at least about 5 mg/ml, at least about 10 mg/ml, at least about 25 mg/ml or at least about 50mg/ml in water at ambient temperature.

51. A composition according to any of claims 1-48, wherein the at least one opioid has a solubility of at least about 3 mg/ml such as, e.g., at least about 5 mg/ml, at least  
25 about 10 mg/ml, at least about 20 mg/ml, at least about 50 mg/ml or at least about 100 mg/ml in water at ambient temperature.

52. A composition according to claim 51, wherein the matrix composition comprises a pharmaceutically acceptable excipient, which has a solubility of at the most about 3  
30 mg/ml such as, e.g., at the most about 1 mg/ml, at the most about 0.1 mg/ml, at the most about 0.05 mg/ml such as, e.g. at the most about 0.001 mg/ml in water at ambient temperature.

53. A composition according to any of the preceding claims, wherein in the aqueous  
35 medium in which the composition is to be used, the coating does not completely crumble or erode before the matrix has completely eroded.

54. A composition according to any of the preceding claims, wherein said first cellulose derivative is a cellulose ether which, when heated, is shapeable by molding or extrusion, including injection molding, blow molding and compression molding.

5 55. A composition according to claim 54 in which the cellulose ether comprises at least one ethylcellulose.

56. A composition according to any of claims 1-53 in which said first cellulose derivative is selected from the group consisting of cellulose acetate, cellulose propionate and cellulose nitrate.  
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57. A composition according to any of the preceding claims in which said second cellulose derivative is selected from the group consisting of methylcellulose, carboxymethylcellulose and salts thereof, cellulose acetate phthalate, microcrystalline cellulose, ethylhydroxyethylcellulose, ethylmethylcellulose, hydroxyethylcellulose, hydroxyethylmethylcellulose, hydroxypropylcellulose, hydroxymethylcellulose and hydroxymethylpropylcellulose.  
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58. A composition according to claim 57 in which said salt of carboxymethylcellulose is selected from the group consisting of alkali metal and alkaline earth metal salts.  
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59. A composition according to any of the preceding claims, in which said plasticizer is selected from the group consisting of phosphate esters; phthalate esters; amides; mineral oils; fatty acids and esters thereof with polyethylene glycol, glycerin or sugars; fatty alcohols and ethers thereof with polyethylene glycol, glycerin or sugars; vegetable oils and hydrogenated vegetable oils; nitrobenzene, carbon disulfide,  $\beta$ -naphthyl salicylate, phthalyl glycolate, and dioctyl phthalate.  
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60. A composition according to claim 59 in which said fatty alcohol is selected from the group consisting of cetostearyl alcohol, cetyl alcohol, stearyl alcohol, oleyl alcohol and myristyl alcohol.  
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61. A composition according to any of the preceding claims in which said plasticizer is a non-ionic surfactant.  
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62. A composition according to any of the preceding claims, wherein the matrix composition does not contain polyethylene glycol 2000 monostearate or polyethylene

glycol 400 monostearate. A composition according to any of the preceding claims, wherein the pharmaceutically acceptable excipient is present and is selected from mannitol, xylitol, sorbitol and inositol.

5 63. A composition according to any of claims 1-62, wherein the pharmaceutically acceptable excipient is an aluminium oxide

64. A composition according to any of the preceding claims, wherein comprising PEO  
10 200,000 as polymer and mannitol and/or aluminium oxide as pharmaceutically acceptable excipient.

65. A method for treating a patient suffering from pain sensible to an opioid comprising administering such opioid in a composition according to any of claims 1-64.

15 66. A method according to claim 65, wherein the amount of opioid on a daily basis sufficient to threat the pain in the patient is less than the amount of opioid sufficient to treat the pain to a similar degree by use of an immediate release composition.

20 67. A method according to claim 66, wherein the degree of pain treatment is measured by use of a 4 point verbal rating scale (VRSpi) where 0=none pain, 1=slight pain 2=moderate pain, 3=severe pain.

25 68. A method according to claim 65 wherein the treatment is associated with less side effects compared to a treatment with a similar amount of opioid in an immediate release composition.

69. A method according to claim 68 where the side effects is selected from the group consisting of sedation, nausea, dizziness, vertigo, obstipation, urine retention, itching, perspiration, dry mouth, break trough pain etc.

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